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POLIOMYELITIS.

FURTHER ATTEMPTS TO TRANSMIT THE DISEASE THROUGH THE AGENCY OF THE STABLE FLY (STOMOXYS CALCITRANS).

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In an experiment previously reported[1] we were able to confirm the observations of Rosenau and Brues[2] that poliomyelitis may be transmitted from monkey to monkey through the agency of *Stomoxys calcitrans.*

The conditions and results of our experiment were as follows: A rhesus monkey (No. 242) inoculated intracerebrally with poliomyelitis virus October 3, 1912, was exposed *two hours after inoculation* and daily thereafter for about two hours to the bites of some 300 Stomoxys, which had been collected in various localities in Washington. This monkey developed characteristic paralysis October 7 and died during the ensuing night. A second monkey, which had been similarly inoculated October 5, was exposed in the same cage October 7, 8, and 9. This monkey developed paralysis October 9 and died the same day.

Fresh monkeys were exposed to the bites of these same flies as follows: Beginning October 4 two monkeys (Nos. 241 and 243) and beginning October 5 a third monkey (244) were exposed for two hours daily, along with the inoculated monkeys. Of the three fresh monkeys two became paralyzed October 12 and the third October 13. Two of these animals showed at autopsy slight tuberculous lesions, not sufficient, however, to indicate that death had been due to tuberculosis. The cords of all three showed typical histological lesions of poliomyelitis.[3] Several monkeys inoculated with the cord of one of these animals promptly developed typical, fatal poliomyelitis, and their cords have in turn been used successfully for the propagation of the infection in still other monkeys.

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[1] Anderson, John F., and Frost, W. H.: Transmission of Poliomyelitis by means of the Stable Fly (*Stomoxys calcitrans*). Public Health Reports, Washington, 1912, vol. xxvii, pp. 1733–1735.

[2] Rosenau, M. J., and Brues, Charles T.: Some experimental observations upon monkeys, concerning the transmission of poliomyelitis through the agency of *Stomoxys calcitrans*. Monthly bulletin, State Board of Health of Mass., Boston, 1912, vol. 7, No. 9, pp. 314–317.

Same: Verbal announcement at the Fifteenth International Congress on Hygiene and Demography, Washington, D. C., Sept. 26, 1912.

[3] At the time of our first report we had examined the cord of only one of these monkeys, and were therefore not able to state definitely that all three were actually infected with poliomyelitis.

There is, then, no doubt that the three monkeys exposed to the bites of Stomoxys which at the same time had access to inoculated monkeys became infected with poliomyelitis. Since the whole history of experimental poliomyelitis is against the assumption that these animals became infected by mere contact with the inoculated animals, the conclusion is fully justified that the infection was transmitted through the agency of the flies—presumably through their bites.

The incubation periods in the exposed monkeys were seven, eight, and nine days, respectively. The incubation period in the monkeys intracerebrally inoculated with the same virus was in this experiment four days, and in other experiments usually from three to seven days. Any cycle of development which the virus may have undergone in the Stomoxys before the latter became infective must therefore have been very short—probably not over two to five days. As a matter of fact, allowing for a somewhat more prolonged incubation after the inoculation of small amounts of virus through Stomoxys than after direct intracerebral inoculation of much larger amounts, it seems quite probable that the transference of infection in this experiment was merely mechanical—that the virus did not undergo any essential cycle of development in the Stomoxys.

Following this experience we have carried out several series of more extended experiments, designed to throw light upon the conditions necessary for the transference of infection through Stomoxys. Contrary to the expectations which were justified by our first experience, the results of all our later experiments have been entirely negative. Not once since our first experiment have we been able to transmit the infection through Stomoxys.

Without going into detail we may summarize our subsequent experiments as follows:

1. Two monkeys inoculated intracerebrally October 24 were exposed to the bites of Stomoxys as follows: October 25 and 26 in cage A, to about 1,000 Stomoxys; October 27 and 28 in cage B, to about 700 Stomoxys (one monkey died October 28); October 29 and 30 in cage C, to about 500 Stomoxys. (Only one monkey remaining October 29 and 30. This monkey paralyzed October 29; died October 30.)

Fresh monkeys were exposed in these cages as follows:

(*a*) Two monkeys in each cage, along with the inoculated monkeys; that is, for two days. These six monkeys were then kept under observation, with no further exposure to Stomoxys.

(*b*) Two more fresh monkeys were then exposed in each cage for several days, beginning five days after the last exposure of inoculated monkeys in that cage. The flies during the five days' interval were fed on fresh guinea pigs.

The object of this experiment was to determine, first, the period at which inoculated monkeys are infective; and, second, whether the virus must undergo any cycle of development in the Stomoxys before they become infective for fresh monkeys. Our first experiment had shown the period of extrinsic incubation, if any, did not exceed five to eight days.

2. Defibrinated blood obtained daily from the inoculated monkeys used in the foregoing experiments was fed to Stomoxys, which were allowed to bite two fresh monkeys shortly after each feeding. The exposure of the fresh monkeys was continued 11 days after the last feeding on defibrinated blood. By this time only about 10 flies remained of the 500 with which the experiment was started.

3. Flies caught in the immediate vicinity of the residences of poliomyelitis patients in Buffalo, N. Y., where poliomyelitis was epidemic at that time, were shipped to the Hygienic Laboratory and allowed to bite fresh monkeys. Two of these experiments were carried out, from 100 to 200 flies being used in each experiment, and the exposure of the monkeys being continued until almost all the flies had died—that is, for about two weeks.

4. A yearling colt inoculated intravenously and intracerebrally with a large amount of poliomyelitis virus was placed in a carefully fly-proofed stable with about 2,500 Stomoxys, and two monkeys were exposed daily to the bites of these flies. This experiment was carried out during the latter half of November with flies caught in the vicinity of the laboratory. The temperature of the stable was considerably modified by a stove kept in an adjoining room and was probably from 55° to 70° F., but no detailed temperature record was kept. The flies were active at first and fed freely, but were nearly all dead at the end of two weeks.

The colt showed no ill effects whatsoever from the inoculation. A monkey inoculated intracerebrally and intraperitoneally with 5.5 c. c. of defibrinated blood obtained from this colt 24 hours after inoculation of the latter remained quite well.

5. A monkey inoculated intracerebrally November 7 was exposed *two hours later* and daily thereafter until death (Nov. 13) in a cage containing originally about 700 Stomoxys. A fresh monkey was exposed daily to the same flies from November 8 to 30, being placed in the cage along with the inoculated monkey during the life of the latter.

6. A monkey inoculated intracerebrally December 17 *was exposed the next day* and daily thereafter until death (Dec. 21) in a cage containing originally about 300 Stomoxys which had been reared in the laboratory. A fresh monkey was exposed daily in the same cage

from December 18 to 24, by which time practically all the flies had died. The temperature during this time was maintained constantly between 75° and 85° F.

7. A monkey inoculated intracerebrally January 13, 1913, was *exposed two hours later* and daily thereafter in a cage with about 300 Stomoxys which had been bred in the laboratory. This animal developed partial paralysis January 7, but during the week following recovered almost completely. Another monkey inoculated January 23 was then exposed in this cage daily until death, January 27. Two fresh monkeys were exposed in this same cage daily from January 14 to February 8, when the experiment was discontinued on account of the death of the flies.

8. Another experiment, a repetition of the above, was carried out from February 10 to 21, 1913.

9. About 60 Stomoxys bred in the laboratory were fed on two successive days with a mixture of poliomyelitis virus (emulsion of cord) and fresh defibrinated blood from a normal monkey. The day following their second feeding and daily thereafter for nine days these flies were fed upon a fresh monkey, which remained well.

The last three experiments were carried out in a room *kept at a temperature of 75° to 80° F.*

In view of the prompt infection of all three of the monkeys used in our first experiment the uniformly negative results of our later experiments were quite unexpected. Up to this time we have found no satisfactory explanation for the discrepancy in results. The flies used in our later experiments have been generally as numerous and active and have fed as freely as those used in our first experiment. In some of our later experiments the inoculated monkeys have been exposed as promptly after inoculation as in our first experiment; that is, after only two hours. In the last four experiments reported above the temperature of the room in which the flies were kept was maintained at approximately summer temperature.

The question has occurred to us whether the season of the year has any peculiar influence upon the outcome of such experiments. Our own first experiment as well as the experiments of Rosenau and Brues were carried out in the early autumn, during the season when poliomyelitis is commonly quite prevalent in nature. Our later experiments, in the late autumn and winter months, were carried out during a season when poliomyelitis is, in nature, quite rare. Although there is no obvious reason why the season per se, regardless of the temperature maintained, should exert any special influence upon the outcome of such experiments, it appears to us worth while to repeat our work during the summer and fall.

In the meantime, until the conditions necessary for the experimental transmission of poliomyelitis through the agency of stomoxys calcitrans have been more fully worked out, it is impossible to estimate accurately the importance which this insect may play in the natural transmission of the disease. That it is an important factor appears to us extremely doubtful, not only because of our series of negative results, but also because recent experiments have afforded additional evidence of the direct transmissibility or contagiousness of poliomyelitis, and because epidemiological studies appear to us to indicate that the disease is more likely transmitted largely through passive human virus carriers.

Nevertheless, the negative results of the experiments which we have reported need not be taken as conclusive. It may be recalled that the demonstration of the infectiousness of the nasal and buccal secretions of poliomyelitis patients was made only after a very considerable number of experiments in this line had been performed with entirely negative results. The same is true as regards the demonstration of passive human virus carriers, and, to some extent, as regards the susceptibility of monkeys to infection through the intact nasal mucosa.

SMALLPOX IN GERMANY DURING 1908-9.[1]

For nearly 40 years Germany has had a law requiring the vaccination of all infants and revaccination of children after the lapse of a number of years. This law, it is understood, has been enforced generally throughout the Empire, with the result that Germany remains practically free from smallpox.

1908.[2]

During the year 1908 there were 434 cases of smallpox reported from 200 localities in the German Empire. Of these 65 terminated fatally. This gives a fatality rate of 15 per cent. Approximately a third of the cases, namely, 153, or 35.25 per cent, occurred in foreigners. Of the foreigners 133 were Russians, 5 Austrians, 4 Hollanders, 4 Italians, 4 Brazilians, 2 Spaniards, and 1 East Indian.

The cases occurred by months as follows: January, 34; February, 27; March, 43; April, 142; May, 95; June, 26; July, 20; August, 22; September, 4; October, 6; November, 3; and December, 12.

As to sex 238, or 54.8 per cent, were males, and 196, or 45.2 per cent, females.

Of the patients 2 had previously had smallpox. One case was in a man 44 years of age who had the disease in childhood and bore on his face and body the scars resulting from his preceding attack. The

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[1] A review of smallpox in Germany during 1907 appeared in the Public Health Reports, Vol. XXV, No. 6, Feb. 11, 1910, pp. 145-148.

[2] Abstracted from the Medizinal-Statische Mitteilungen aus dem Kaiserlichen Gesundheitsamte, Band XIII, s. 213-231.